Claims

1. A protected capillary, comprising:
a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface; and
a rigid tube having a proximal end and a distal end, an interior surface and an exterior surface, the exterior surface of the glass capillary being bonded to the interior surface of the rigid tube.

2. The protected capillary of claim 1, wherein the glass capillary is made from fused silica.

3. The protected capillary of claim 1, wherein the rigid tube is made from stainless steel.

4. The protected capillary of claim 3, wherein the stainless steel rigid tube is made from hypodermic needle tubing.

5. The protected capillary of claim 1, wherein the distal end of the glass capillary is formed into a nozzle.

6. The protected capillary of claim 1, wherein the rigid tube has at least one aperture formed therein.

7. The protected capillary of claim 6, wherein the rigid tube has two apertures formed therein.

8. The protected capillary of claim 5, wherein the rigid tube has at least one aperture formed therein.

9. The protected capillary of claim 8, wherein the rigid tube has two apertures formed therein.

10. The protected capillary of claim 8, wherein the nozzle is adjacent one of the two apertures.

11. The protected capillary of claim 1, wherein the proximal end of the glass capillary protrudes beyond one end of the rigid tube.

12. The protected capillary of claim 1, further comprising a female Luer fitting bonded to the distal end of the rigid tube.

13. The protected capillary of claim 1, wherein the distal ends of the glass capillary and the rigid tube are ground to a sharp point.

14. The protected capillary of claim 1, wherein the distal end of the glass capillary is formed into a nozzle and the distal end of the rigid tube is ground to a sharp point.

15. The protected capillary of claim 5, further comprising a female Luer fitting bonded to the distal end of the rigid tube.

16. A piezoelectric pipetting device, comprising:

a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface, the distal end being formed into a nozzle;

a rigid tube having two ends, an interior surface and an exterior surface, a first portion of the exterior surface of the glass capillary being bonded to the interior surface of the rigid tube; and

a piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary.

17. The piezoelectric pipetting device of claim 16, wherein the glass capillary is made from fused silica.

18. The piezoelectric pipetting device of claim 16, wherein the rigid tube is made from stainless steel.

19. The piezoelectric pipetting device of claim 18, wherein the stainless steel rigid tube is made from hypodermic needle tubing.

20. The piezoelectric pipetting device of claim 16, wherein the piezoelectric actuating element is protected by a protective housing that surrounds the piezoelectric actuating element, the protective housing being electrically non-conductive.

21. The piezoelectric pipetting device of claim 16, wherein the piezoelectric actuating element is protected by an electrically conductive protective housing having surfaces, the surfaces being coated with an electrically non-conductive layer.

22. The piezoelectric pipetting device of claim 16, wherein the piezoelectric actuating element has circumferential electrical contacts and is protected by an electrically conductive protective housing having surfaces, the surfaces being coated with an electrically non-conductive layer.

23. The piezoelectric pipetting device of claim 16, further comprising:

an electrical connector adapted to be removably connected to the circumferential electrical contacts of the piezoelectric actuating element.

24. A piezoelectric pipetting device, comprising:

a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface, the distal end being formed into a nozzle;

a rigid tube having two ends, an interior surface and an exterior surface, a first portion of the exterior surface of the glass capillary being bonded to the interior surface of the rigid tube;

a piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary; and

a sensor adjacent a third portion of the exterior surface of the glass capillary.

25. The piezoelectric pipetting device of claim 24, wherein the glass capillary is made from fused silica.

26. The piezoelectric pipetting device of claim 24, wherein the rigid tube is made from stainless steel.

27. The piezoelectric pipetting device of claim 26, wherein the stainless steel rigid tube is made from hypodermic needle tubing.

28. The piezoelectric pipetting device of claim 24, wherein the piezoelectric actuating element is protected by a protective housing that surrounds the piezoelectric actuating element.

29. A piezoelectric pipetting device, comprising:

a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface, the distal end being formed into a nozzle;

a rigid tube having two ends, an interior surface and an exterior surface, a first portion of the exterior surface of the glass capillary being bonded to the interior surface of the rigid tube;

a piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary; and

a temperature regulator adjacent the exterior surface of an end of the glass capillary.

30. The piezoelectric pipetting device of claim 29, wherein the glass capillary is made from fused silica.

31. The piezoelectric pipetting device of claim 29, wherein the rigid tube is made from stainless steel.

32. The piezoelectric pipetting device of claim 31, wherein the stainless steel rigid tube is made from hypodermic needle tubing.

33. The piezoelectric pipetting device of claim 29, wherein the piezoelectric actuating element is protected by a protective housing that surrounds the piezoelectric actuating element.

34. A piezoelectric pipetting device, comprising:

a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface, the distal end being formed into a nozzle;

a rigid tube having two ends, an interior surface and an exterior surface, a first portion of the exterior surface of the glass capillary being bonded to the interior surface of the rigid tube;

a piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary;

a sensor adjacent a third portion of the exterior surface of the glass capillary; and

a temperature regulator adjacent the exterior surface of an end of the glass capillary.

35. The piezoelectric pipetting device of claim 34, wherein the glass capillary is made from fused silica.

36. The piezoelectric pipetting device of claim 34, wherein the rigid tube is made from stainless steel.

37. The piezoelectric pipetting device of claim 36, wherein the stainless steel rigid tube is made from hypodermic needle tubing.

38. The piezoelectric pipetting device of claim 34, wherein the piezoelectric actuating element is protected by a protective housing that surrounds the piezoelectric actuating element.

39. A method for making a protected capillary, comprising the steps of:

a) forming a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface;

b) forming a rigid tube having a proximal end and a distal end, an interior surface and an exterior surface; and

c) bonding the exterior surface of the glass capillary to the interior surface of the rigid tube.

40. The method of claim 39, further comprising the step of:
d) forming the distal end of the glass capillary into a nozzle.

41. The method of claim 40, further comprising the step of:
e) forming a protective housing that surrounds the piezoelectric actuating element, the protective housing being electrically non-conductive.

42. The method of claim 40, further comprising the step of:
e) forming an electrically conductive protective housing that surrounds the piezoelectric actuating element, the electrically conductive protective housing having surfaces, the surfaces being coated with a electrically non-conductive layer.

43. The method of claim 42, further comprising the step of:
f) forming circumferential electrical contacts on the piezoelectric actuating element.

44. The method of claim 43, further comprising the step of:
g) removably connecting an electrical connector to the circumferential electrical contacts of the piezoelectric actuating element.

45. The method of claim 39, further comprising the step of:
d) forming at least one aperture in the rigid tube.

46. The method of claim 39, further comprising the step of:
d) bonding a female Luer fitting to the distal end of the rigid tube.

47. The method of claim 39, further comprising the step of:
d) shaping the distal ends of the glass capillary and the rigid tube to a sharp point.

48. A method for making a protected capillary, comprising the steps of:

a) forming a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface;

b) forming the distal end of the glass capillary into a nozzle;

c) forming a rigid tube having two ends, an interior surface and an exterior surface;

d) bonding a first portion of the exterior surface of the glass capillary to the interior surface of the rigid tube;

e) forming a piezoelectric actuating element; and

f) affixing the piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary.

49. The method of claim 48, further comprising the step of:

g) forming a protective housing that surrounds the piezoelectric actuating element, the protective housing being electrically non-conductive.

50. A method for making a piezoelectric pipetting device, comprising the steps of:

a) forming a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface;

b) forming the distal end into a nozzle;

c) forming a rigid tube having two ends, an interior surface and an exterior surface;

d) bonding a first portion of the exterior surface of the glass capillary to the interior surface of the rigid tube;

e) forming a piezoelectric actuating element;

f) affixing the piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary;

g) forming a sensor; and

h) affixing the sensor adjacent a third portion of the exterior surface of the glass capillary.

51. The method of claim 50, further comprising the step of:

i) forming a protective housing that surrounds the piezoelectric actuating element.

52. A method for making a piezoelectric pipetting device,

comprising the steps of:

a) forming a glass capillary having a proximal end and a distal end, an interior surface and an exterior surface;

b) forming the distal end of the glass capillary into a nozzle;

c) forming a rigid tube having two ends, an interior surface and an exterior surface;

d) bonding a first portion of the exterior surface of the glass capillary to the interior surface of the rigid tube;

e) forming a piezoelectric actuating element;

f) affixing the piezoelectric actuating element adjacent a second portion of the exterior surface of the glass capillary;

g) forming a temperature regulator;

h) affixing the temperature regulator adjacent the exterior surface of an end of the glass capillary.

53. The method of claim 52, further comprising the step of:

i) forming a protective housing that surrounds the piezoelectric actuating element.

54. A method for using a piezoelectric pipetting device, comprising the steps of:

a) actuating a piezoelectric actuating element, adjacent a first portion of an exterior surface of a glass capillary having a proximal end and a distal end, to draw a fluid into the glass capillary, a second distinct portion of the exterior surface of the glass capillary being bonded to an interior surface of a rigid tube;

b) accessing a sensor adjacent a third portion of the exterior surface of the glass capillary to determine an operational state of the fluid; and

c) determining an action based on the operational state of the fluid.